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Process for selecting a transmission channel and receiver of signals with antenna diversity

BACKGROUND OF THE INVENTION

1. Field of the Invention

The invention relates to wireless digital communication systems with antenna diversity using OFDM (standing for Orthogonal Frequency Division Multiplex) type modulation. The antenna diversity helps to improve the quality of the transmission link in terms of reliability and robustness. Such communication systems are used for example in local wireless networks of the IEEE 802.11a or Hiperlan2 type which use burst transmission.

2. Description of the Prior Art

To find out more about transmissions using modulation of OFDM type, the person skilled in the art can consult: Allard M. et LASSALLE R., "Principes de modulation et de codage canal en radiodiffusion numérique vers des mobiles." [Principles of modulation and channel coding in digital radio broadcasting to mobiles], UER-Technique journal, No. 224, August 1987, pp. 168-190; M.C.D. Maddocks, "An introduction to digital modulation and OFDM techniques", BBC Research and Development Report, BBC RD 1993/10 ; Le Floch B., Alard M. and Berrou C., "Coded Orthogonal Frequency Division Multiplex", Proceedings of the IEEE, vol. 83, No. 6, June 1995, pp. 982-996.

More particularly, the invention pertains to a process for selecting an antenna from several antennas available at the input of an OFDM radio signals receiver with antenna diversity, with a view to favouring the transmission channel delivering a signal leading to the lowest binary error rate after decoding.

To calculate the binary error rate on a transmission channel, one generally makes use of a certain number of bits of the preamble of each frame dispatched in the radio signal which is transmitted by the channel. However, this calculation is expensive in terms of time because it is

necessary to decode a large number of bits and it is not suited to an antenna diversity receiver having to undergo temporally frequent changes of reception antenna.

SUMMARY OF THE INVENTION

The aim of the invention is to propose a process better suited to the selecting of a reception antenna of an antenna diversity receiver.

For this purpose, according to the invention, the process consists in estimating the binary error rate for each transmission channel by feeding a neural network with data representative of the frequency response of the transmission channel. Data representative of the frequency response of a transmission channel may be provided by a module for calculating the fast Fourier transform, which module already exists in the signal processing chain of an OFDM signals receiver. The Fourier transform calculation module is furnished with means which make it possible to calculate the frequency response of the channel over a sequence corresponding to the preamble. On receipt of the preamble of a frame in the radio signal, this module for calculating the fast Fourier transform calculates the frequency response of the transmission channel and this response is used by the equalizer to calculate the initial value of each of its equalization coefficients. On the basis of the frequency response of the transmission channel and of the power level of the signal received on the input, the neural network can estimate the binary error rate corresponding to a transmission channel.

To favour a simple structure for the neural network and in particular a structure based on the multilayer perceptron model, the neural network has undergone learning to evaluate, on the basis of the data representative of the response of the transmission channel, the power level of the signal on the input which would be necessary to obtain a predetermined binary error rate, for example a standard error rate of 10^{-4}, and the output of the neural network is used with data representative of

the actual power level of the signal received on the input so as to evaluate the binary error rate for this transmission channel.

The invention extends to an antenna diversity receiver for the implementation of the above process.

BRIEF DESCRIPTION OF THE SOLE FIGURE

The process according to the invention is illustrated in the single figure showing a signal processing chain of an OFDM signals receiver with antenna diversity.

DESCRIPTION OF A PREFERRED EMBODIMENT

In the figure, the receiver comprises by way of nonlimiting example two transmission channels 1 and 2, each consisting of an antenna. The said channels are connected via a switch 3 to the input of the signal processing chain of the receiver.

The signal processing chain of the receiver comprises in a conventional manner in this order, a frequency changer 4 which lowers the frequency of the input radio signal, an analogue/digital converter 5 in which the power level P of the signal received is among other things evaluated, a fast Fourier transform calculation module 6, an equalizer 7 and a demodulator/decoder 8.

The input radio signal transports bits organized into packets, each packet commencing with a defined preamble. In the module 6, the bits of the preamble of each packet are used to calculate the frequency response of the RFC transmission channel, these RFC data then being used in the equalizer 7 for the calculation of the initial equalization coefficients.

The RFC data representative of the frequency response of a transmission channel are also diverted to a neural network 9 which serves to evaluate the binary error rate for the selected transmission channel. On the basis of an evaluation of the binary error rate for each transmission channel 1 and 2, the shifting of the switch 3 is controlled automatically so as to

favour the transmission channel leading to a decoded signal with the lowest binary error rate.

The RFC data are normalized in terms of power. This is why the result obtained with the neural network 9 indicates the power necessary in order to obtain a given error rate.

Represented in the figure is a block 10 which controls the shifting of the switch 3. This block receives the power level P of the signal received at the input of the receiver and the output of the neural network 9 which is a neural network constructed according to the multilayer perceptron model. This model is known for its simplicity of implementation in microcircuits and also because the learning algorithms which it uses, of the error back-propagation type, are well known.

The neural network 9 has undergone learning to evaluate, on the basis of the RFC data representative of the response of a transmission channel, the power level of the signal on the transmission channel which would be necessary to obtain a predetermined binary error rate at the output of the demodulator/decoder 8, for example an error rate of 10^{-4}. The database used for the learning of the neural network contains a set of channel responses normalized in terms of power and for each of them, the signal power necessary at the input of the receiver (at the antenna level) to obtain a binary error rate of 10^{-4} at the output of a Viterbi decoder matched to the rate of the code used on the transmitted signal. This "necessary power" represents the sensitivity of the receiver. Each element of the base can be obtained by simulation or by measurement. Simulation has the advantage of leading to reliable and accurate results but demands enormous calculation times. Measurement makes it possible to obtain a very large number of elements very rapidly but it must be done with particular care in order for these results to be reliable and moreover, the accuracy of the result obtained is limited. To guarantee a sufficient level of learning, the number of elements contained in the database must be at least a few hundred. Additionally, these elements must be distributed as uniformly as possible at the sensitivity level. By way of example, a single-antenna receiver coupled

with a spatial positioner and a software tool making it possible to automate the measurements have been used to produce the data base. In order to guarantee the stability of the transmission channel so as to obtain the most reliable results possible, the measurements are conducted at night in an environment devoid of any human activity.

On the basis of the output of the neural network 9, that is to say an estimated necessary signal power level, and of the actual power level P of the signal received at the antenna level, an estimation of the binary error rate for the transmission channel can be made using a calculation algorithm in the block 10. When it has estimated the binary error rate for the two transmission channels, the block 10 can control the switch 1 in such a way as to connect the input of the signal processing chain of the receiver to the antenna delivering an OFDM signal having the smallest estimated error rate.

More simply, it is also possible to compare the necessary power estimated by the neural network with the power received so as to obtain for each antenna and hence for each transmission channel a safety margin. The choice of antenna is made on the basis of the greatest safety margin.

Other variant embodiments are possible. By way of example, it is possible to use data representative of the frequency response of the transmission channel other than the RFC data. The equalization coefficients of the equalizer may for example be used but this is more expensive to implement.

It is also possible to integrate a data item representative of the input power into the neural network. In this case, the neural network provides the information choice of channel regarding directly. However, it is preferable to use only similar data in the neural network so as to simplify the learning.